FINAL REPORT

RESEARCH WORK ORDER NO. 184

LANDSCAPE LEVEL ASSESSMENT OF THE RELATIONSHIP OF HYDROLOGIC CONDITIONS TO TREE ISLAND IN WATER CONSERVATION AREA 3

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Landscape level assessment of the relationship of hydrologic conditions to tree islands in Water Conservation Area 3

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Introduction

Water Conservation Area 3 is the largest of the water conservation areas covering approximately 2442 km^2 (914 mi^2). The habitats within this area of central Everglades marsh range from sloughs and wet prairies to sawgrass, brush, and tree islands. Elevation in WCA 3 ranges from 4 m (13 ft) in the north to 2.4 (6 ft) in the south (Schortemeyer 1980). This elevation gradient along with micro-elevation patterns, fire, and water management practices help to determine the distribution of the various habitats. Tree islands are areas that are slightly higher in elevation than the surrounding marsh where woody vegetation grows. Tree islands may form over rock outcrops or as a result of the build up of peat deposits. Tree islands cover approximately 1-2% of WCA 3 and are one of the most distinguishing features of the Everglades (Loveless 1959). They are important ecologically as sites of high botanical species richness and as habitat for species such as wading birds, alligators, turtles, and deer.

Tree islands are an integration of many processes operating over a range of temporal and spatial scales. Changes in water management practices in south Florida since the 1800s have impacted the distribution and health of tree islands. In WCA 3, overdrainage in the north has lead to soil oxidation and to an increase in fire risk. During the 1970s many tree islands were burned as a result of wildfires (Schortemeyer 1980). In the south, alterations in natural hydropatterns resulted in the loss of tree islands due to flooding. Because tree islands are one of the distinguishing features of the Everglades landscape and provide habitat for a wide range of plants and animals restoration efforts need to ensure their conservation. To do this, the impacts of alternative restoration plans on tree islands need to be evaluated using a linkage of site specific biological inventories with landscape level evaluation.

Tree islands are not distributed evenly throughout the WCA 3; therefore, the impacts of changes in hydrology on tree island condition will vary spatially. In evaluating alternative scenarios it will be important to target areas that include areas where conditions are currently suitable for tree islands as well as those areas where conditions are too wet or too dry. This report summarizes the spatial patterns of hydrologic conditions in WCA 3 for the period 1991-1995 and discusses how this type of information can be used with data on tree island distribution and condition to evaluate the effects of alternative hydrologic scenarios on tree islands.

Methods

Data on the distribution of tree island area were obtained using the land cover of south Florida produced by the Florida Cooperative Fish and Wildlife Research Unit as part of the National Gap Analysis program (Florida Cooperative Fish and Wildlife Research Unit Draft V 3.0. unpublished data). The methods for that analysis are presented in Brandt 1998. The data used in the following analysis were the percent of total tree island area in each hydrologic grid cell (see below). For example, if the total area of tree islands within the study area was 100 ha, and 10 ha of that occurred in cell 1 and 5 ha occurred in cell 2, than cell 1 would have a value of 10% and cell 2 a value of 5%.

Hydrology data were obtained form the South Florida Water Management District and are the output from the validation run of V. 3.5 of the Water Management Model for the period January 1991 through December 1995. This model is being used in restoration planning and is the current best estimate of hydrological conditions throughout south Florida. The grid cell size for this model is 3.2 x 3.2 km (2 x 2 mi). The temporal resolution of the data used in this analysis was 1 week. Output values from the model are the weekly average water stage (feet) in each cell.

Average weekly stage and percent of time the stage was above 3, 2, and 1 feet were calculated for each cell for each year and for the entire 1991-1995 period. These stage cutoffs were selected as a starting point for assessing hydrologic impacts to tree islands based on an average tree island elevation of 3 ft (range 0.8-6ft) for 26 tree islands sampled within WCA 3 (L. Heisler, Pers Com.). It is presumed that at a stage of 3 ft or higher most tree islands would be stressed. Stages between 0 and 3 ft were presumed to be more suitable for tree islands. The mean stage data and the variance in stage were plotted by grid cell as a 3-D surface using SigmaPlot. Percent of the 1991-1995 period that the average stage was > 3, 2, or 1 ft were plotted by grid cell using Erdas Imagine. These graphics give a visual representation of the suitability of different areas of WCA 3 for tree islands.

The percent of total tree island area where mean average stage was > 3, 2, and 1 ft also were calculated for the entire 1991-1995 period and compared in table and graphic form to the results using the grid cells. The mean average weekly stage data for all cells and for tree island area were compared for 1991 and 1995 to illustrate the effects of dry (1991) and wet (1995) conditions.

Results and Discussion

Percent of total tree island area per cell ranged from 0 to 7.6% with a mean of 0.45% +- 0.92 and a median of 0.14%. Fifty percent of the tree island area was contained in 16 of the 220 cells. This pattern of tree island distribution shows only where tree islands are present now and not where they existed historically and therefore theoretically could be restored. An analysis of changes in tree island distribution in conjunction with changes in hydrologic conditions would be useful to help identify areas where tree islands could be recreated and to identify hydrologic patterns that are not suitable for tree islands.

Average weekly stage in each cell ranged from 0.39 to 3.92 ft. Twelve percent of the cells had a mean average weekly stage <= 1ft, 38% between 1 and 2 feet, 32% between 2 and 3 ft and 18% > 3ft. Nineteen percent of the tree island area within WCA 3 had a mean average weekly stage <= 1 ft for the period 1991-1995. Forty-four percent between 1 and 2 ft, 29% between 2 and 3 feet, and 7% > 3 ft (Figure 1). A higher percentage of tree island area occurs in areas with a mean average weekly stage < 2.5 ft than would be expected based on the percentage of cells at those stages.

There was a strong spatial trend in the average stages (Figure 2) across WCA 3. Mean average stage was highest in cells near L-67, primarily immediately to the north and east. Mean average stages were lowest in cells in the northwestern portion of WCA 3A. The general north to south trend in stages follows the natural elevation gradient, but has been magnified as a result of water management practices. The areas in the north are drier than they were historically, while the areas in the south are wetter. Cells in the west showed higher and less variability in stage than those in the east (Figure 3). Cells in the south showed higher variances in stage than those in the north. WCA 3B had less variable stages than WCA 3A. The eastern portion of WCA 3B was more variable than the west. Percent of the time the average weekly stage was >3, 2, and 1 feet are presented in Figures 4-6. These graphics combine the variables of depth of water with the duration at that depth and provide a visual tool for assessing impacts to tree islands throughout the conservation area. Graphics like these can be further refined by linking biological data on the actual health of tree islands with longer term hydrologic conditions. Figure 4 shows that for the period 1991-1995 approximately 15% of the area was flooded to at least 3ft 50% or more of the time. This area is primarily along the L-67 and is an area where tree islands are know to have been lost due to flooding. Approximately 75% of WCA 3 had a mean average weekly stage of > 3ft for 0-25% of the time during the 1991-1995 time period. It is undoubtedly the combination of water depth and duration of flooding along with the physical attributes of the tree island that determines it's health and persistence under different hydrologic scenarios.

Figure 7 and Table 1 show the percent of all of the cells and the percent of the total tree island area that experienced a given hydrologic conduction from 1991-1995. Simply calculating the percentage of the study area > 3ft for each percent of time underestimates the tree island area for the 0-25% category and overestimates the impact to tree islands for all categories > 25%. A similar pattern of differences between percentages calculated over all cells and for percentages calculated based on tree island area is seen for the other stages and is a result of the uneven distribution of tree islands in the study area.

A potential use of these type of data is in determining the percent increase or decrease in areas suitable for tree islands under different hydrologic conditions. A first step to that is to determine the biological criteria to use as a cutoff. The important biological attributes of the island that will help to determine these cutoff values will include tree island elevation and species composition. These attributes will determine the flood stage and duration which the island will be able to withstand. Once a range of these attributes is defined, the hydrologic output can be evaluated accordingly. For example, if we determine that any amount of flooding > 3ft or dryout < 0 ft would be detrimental to tree islands we could than compare the output of two or more alternatives to determine which alternative had 1- the least area where flooding or drying occurs and 2- the least area where flooding or over drying would impact tree islands. Figure 8 and Table 2 illustrate this using data from 1991 and 1995. In the 1991 example, very little of the area and very little of the tree island area was flooded > 3ft, and only a small amount of the area and a slightly larger percent of the tree island area experienced dryout. In 1995 about 35% of the area and about 20% of the tree island area were flooded while none of the area dried out. Based on these data we might conclude that the hydrologic conditions in 1991 were more suitable for tree islands than those in 1995. A similar approach could be used to evaluate a range of alternatives. The success of this approach will depend on our ability to define appropriate stage and duration criteria for healthy tree islands.

Literature Cited

Brandt, L.A. 1998. Landscape-level assessment of percent cover of tree islands in hydrologic model grid cells. Unpublished report to U.S. Fish and Wildlife Service Vero Beach, FL.

Loveless, C. M. 1959. A study of vegetation of the Florida Everglades. Ecology. 40:1-9.

Schortemeyer, J.L. 1980. An evaluation of water management practices for optimum wildlife benefits in Conservation Area 3A. Florida Game and Fresh Water Fish Commission Report. Ft. Lauderdale, FL.

List of Tables

Table 1. Percent of time average weekly stage was > 3, 2, or 1 ft during 1991-1995. Results are expressed as either the percent of the cells in the study area or the percent of the total tree island area that experienced each condition.

	Weekly stage > 3ft		Weekly stage > 2ft		Weekly stage > 1ft	
% of time (1991-1995)	% of cells	% of tree island area	% of cells	% of tree island area	% of cells	% of tree island area
0	26	26	3	6	0	0
>0 and <=25%	43	57	34	37	3	5
>25 and <=50%	16	11	20	29	12	15
>50 and <=75%	11	4	13	11	15	20
>75%	4	2	30	17	70	60

Table 2. Percent of cells and percent of total tree island area experiencing different water stages in 1991 and 1995. Data are from the SFWMD water management model V. 3.5 validation run.

	1991		1995	
Mean average weekly stage	% of cells	% of tree island area	% of cells	% of tree island area
<0	1	4	0	0
>0 and < 1ft	26	27	6	9
>1ft and < 2ft	51	62	30	33
>2ft and < 3ft	21	6	28	39
>3ft	1	1	36	19

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Figure 7. Percent of the time that average weekly stage was > 3, 2, or 1 ft in WCA 3 during 1991-1995. Results are expressed as either the percent of all of the cells or percent of the total tree island area that experienced each condition.

Figure 8. Percent of cells and percent of total tree island area experiencing different water stages in 1991 and 1995. Data are from the SFWMD water management model V. 3.5 validation run.

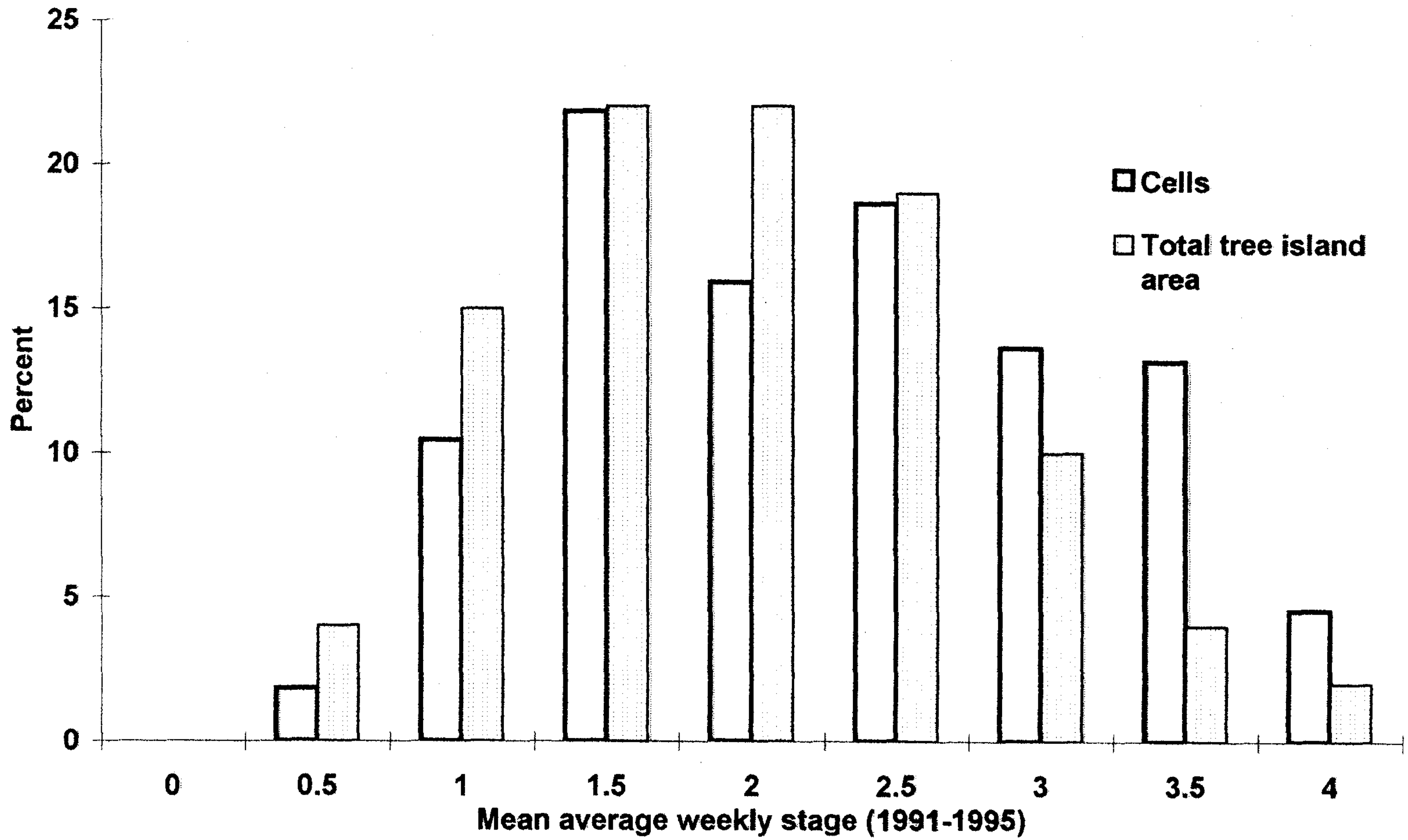


Figure 1. Histogram of mean average weekly stage (ft) in WCA 3 (1991-1995) expressed as either the percent of the 220 cells within the study area or the percent of the total tree island area. Data are from the SFWMD water management model V. 3.5 validation run.

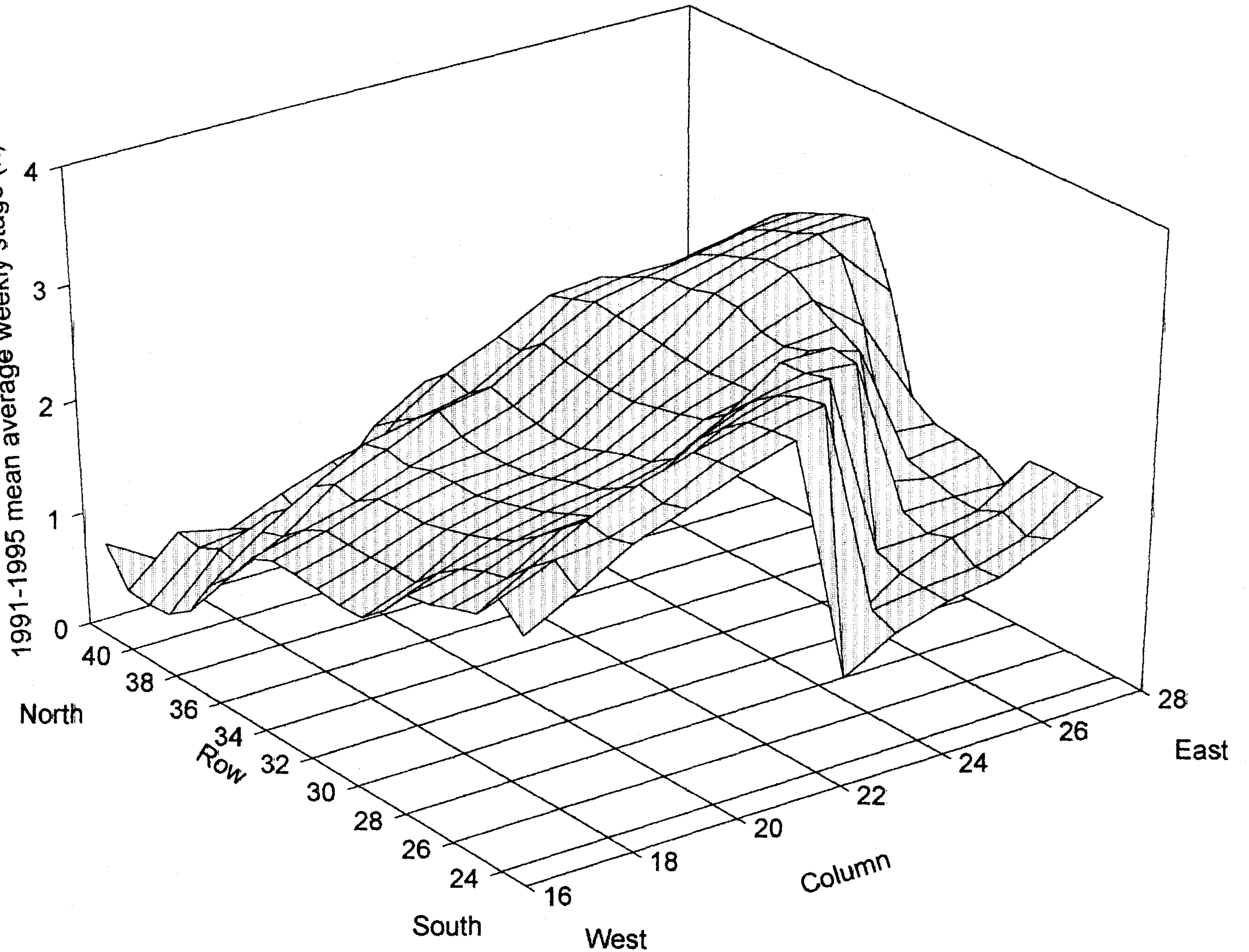


Figure 2. Mean average weekly stage (1991-1995) for each hydrology grid cell within WCA 3. Data are from the SFWMD water management model V. 3.5 validation run. Peak stages occur adjacent to the L-67 canal.

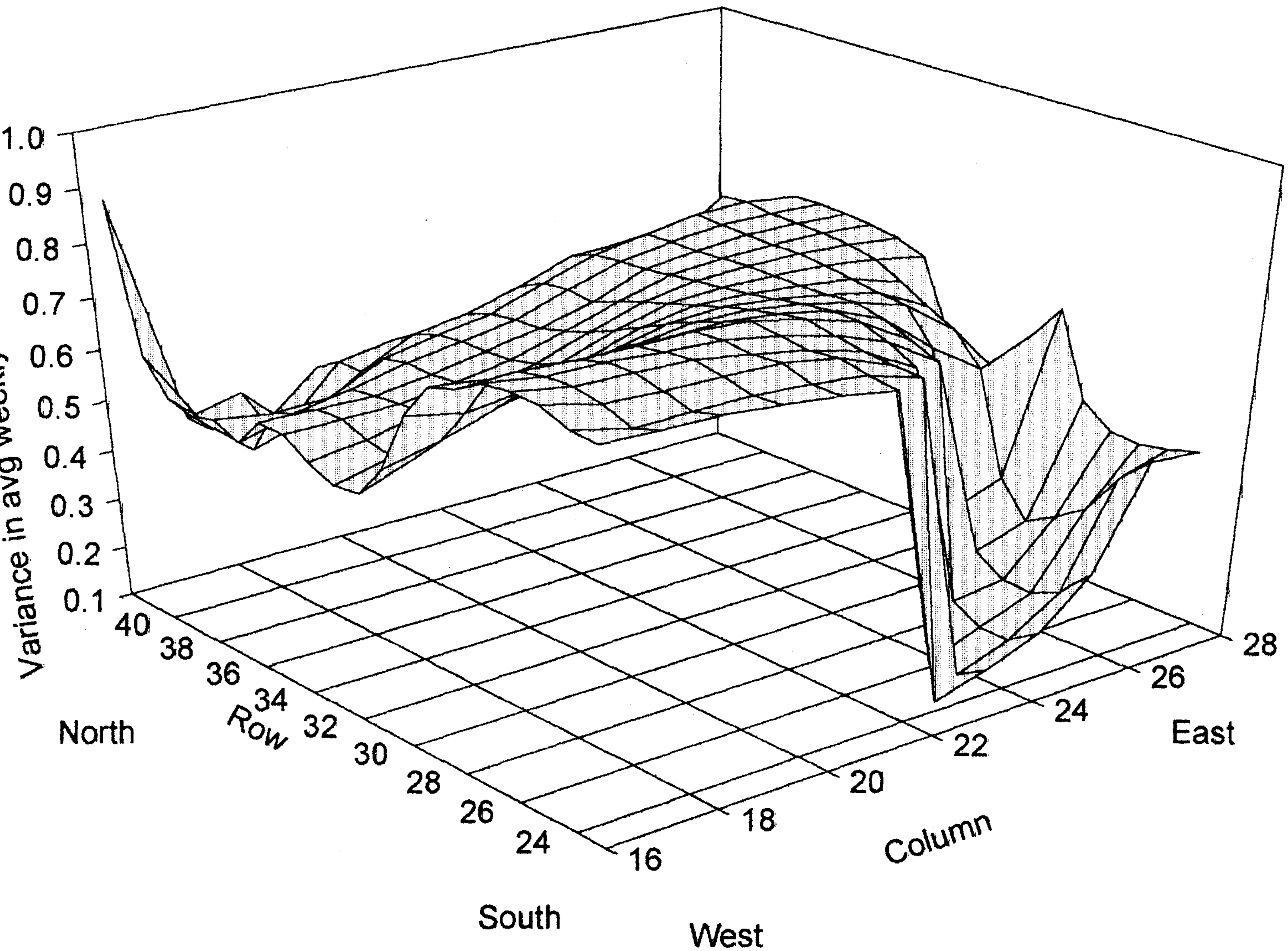


Figure 3. Variance in mean average weekly stage (1991-1995) for each hydrology grid cell within WCA 3. Data are from the SFWMD water management model V. 3.5 validation run.

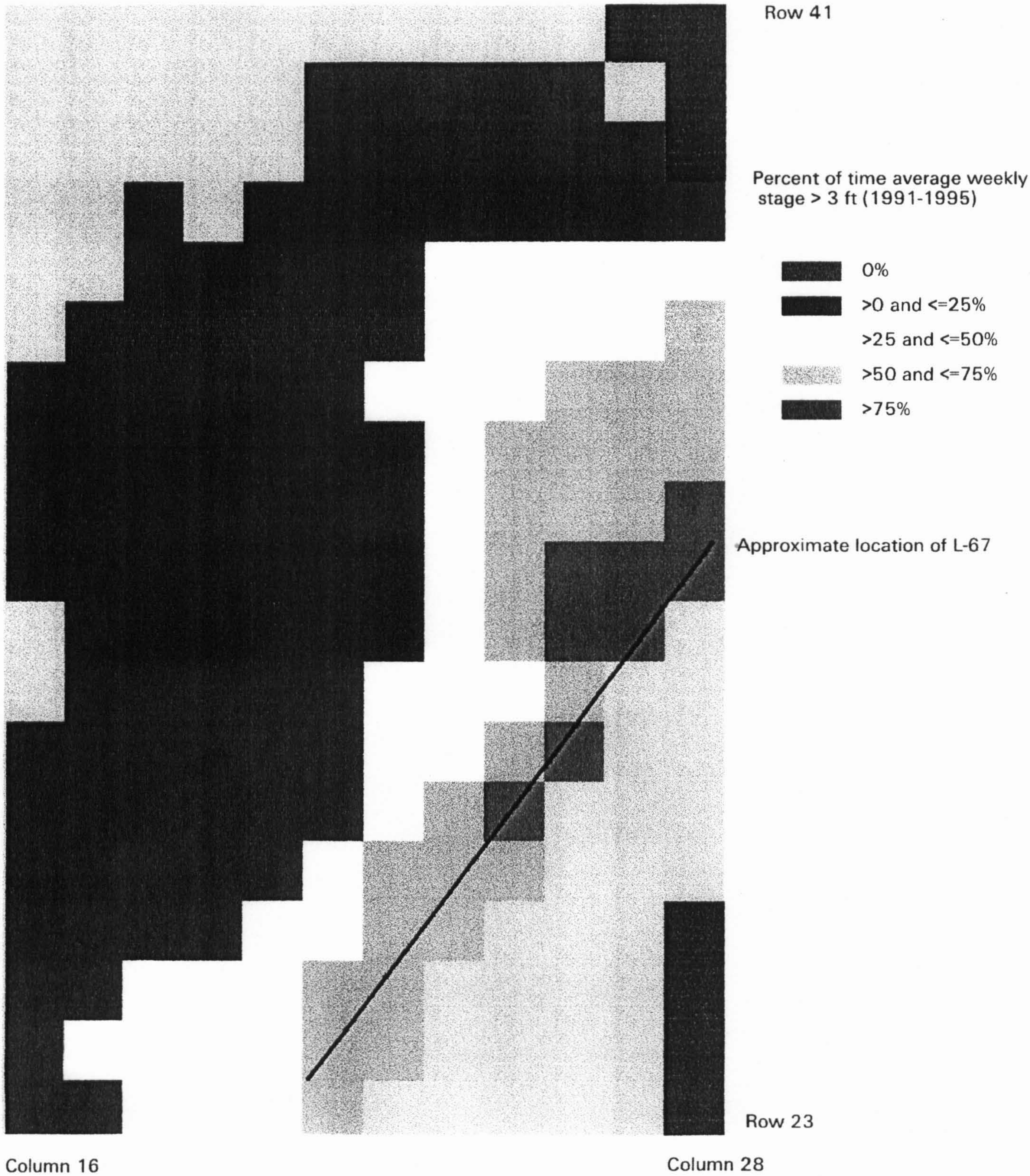


Figure 4. Percent of the time that average weekly stage within WCA 3 was > 3 ft from 1991-1995. Data are from the SFWMD water management model V. 3.5 validation run and are mapped by grid cell.

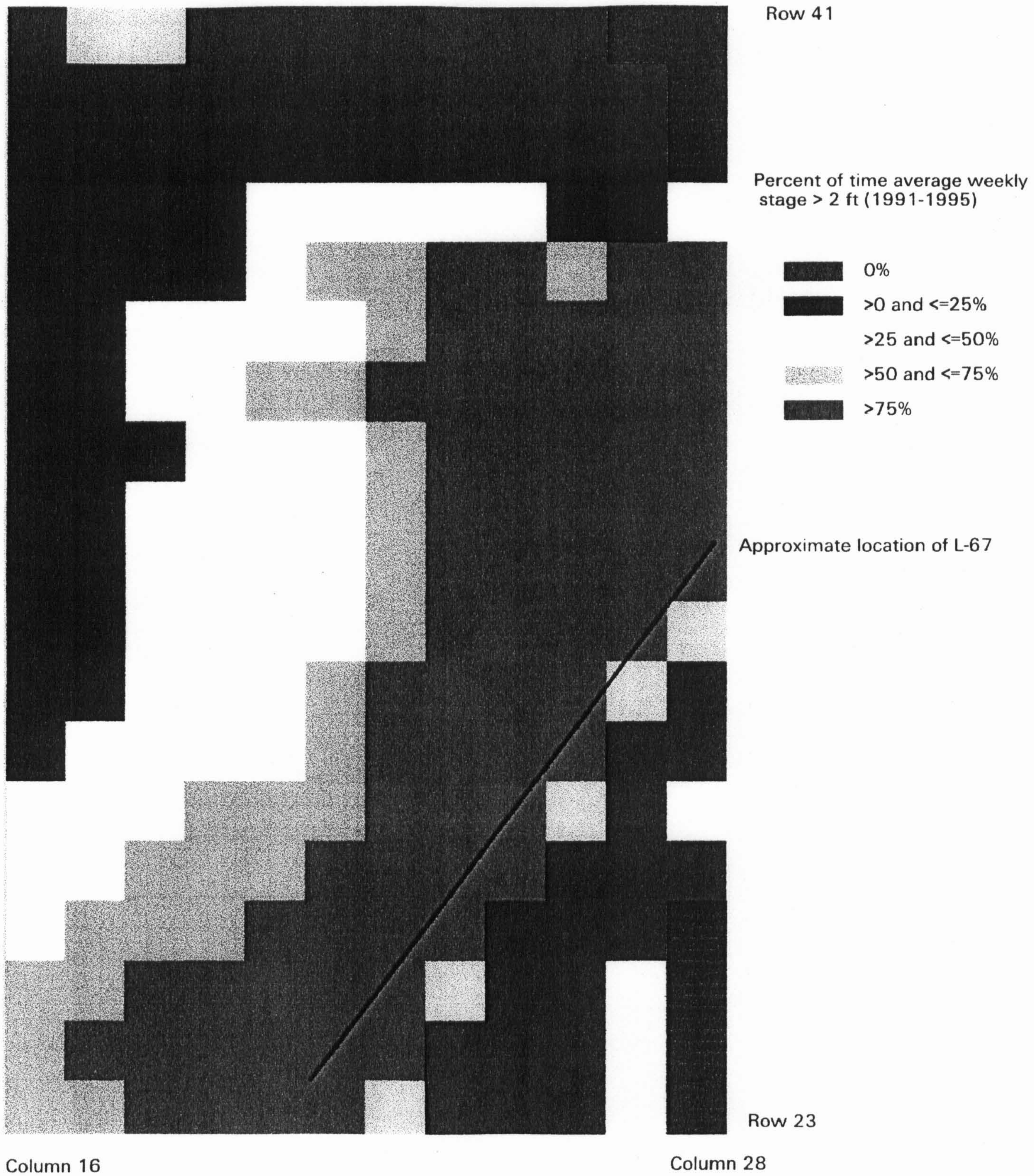


Figure 5. Percent of the time that average weekly stage within WCA 3 was > 2 ft from 1991-1995. Data are from the SFWMD water management model V. 3.5 validation run and are mapped by grid cell.

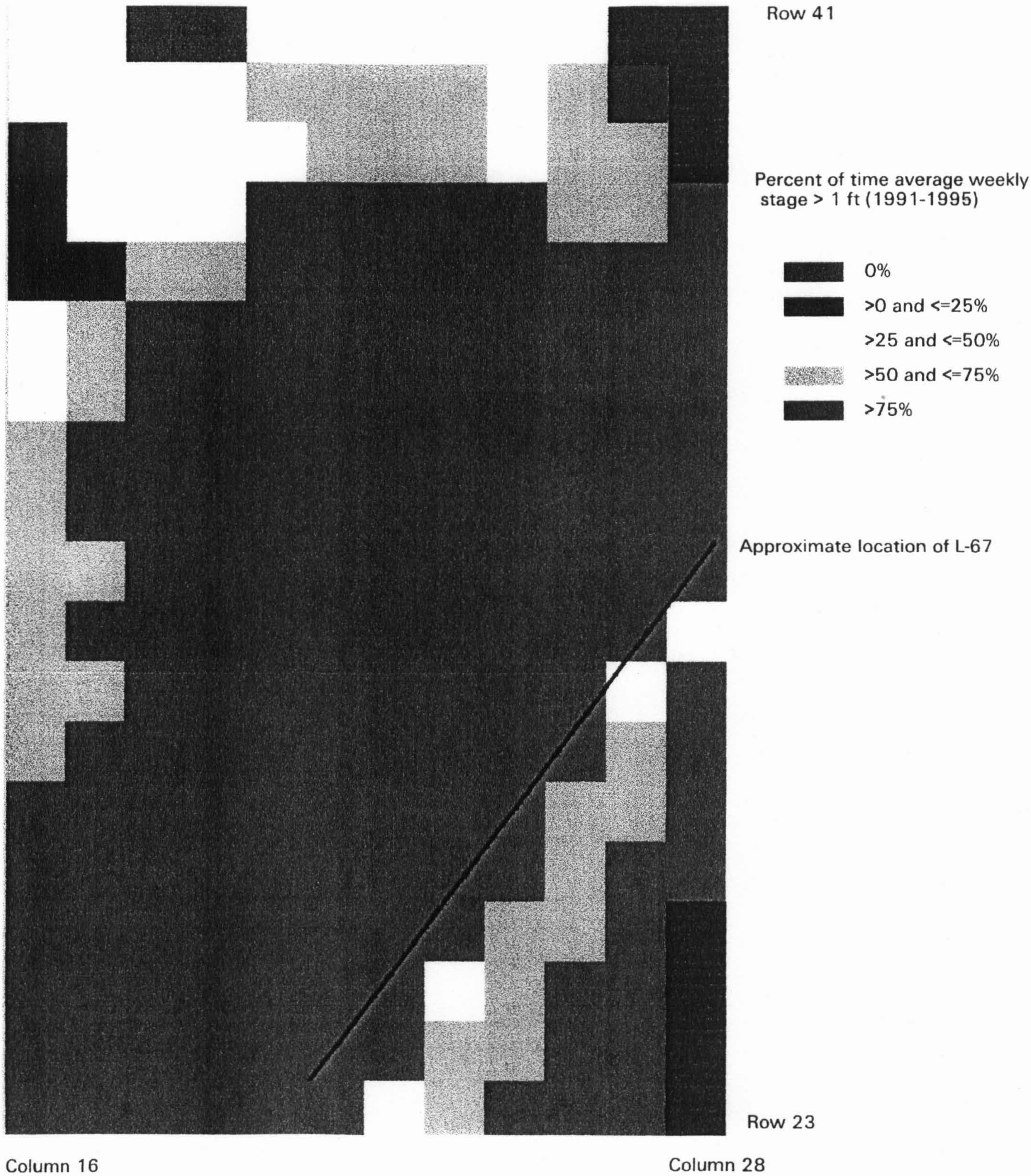


Figure 6. Percent of the time that average weekly stage within WCA 3 was > 1 ft from 1991-1995. Data are from the SFWMD water management model V. 3.5 validation run and are mapped by grid cell.

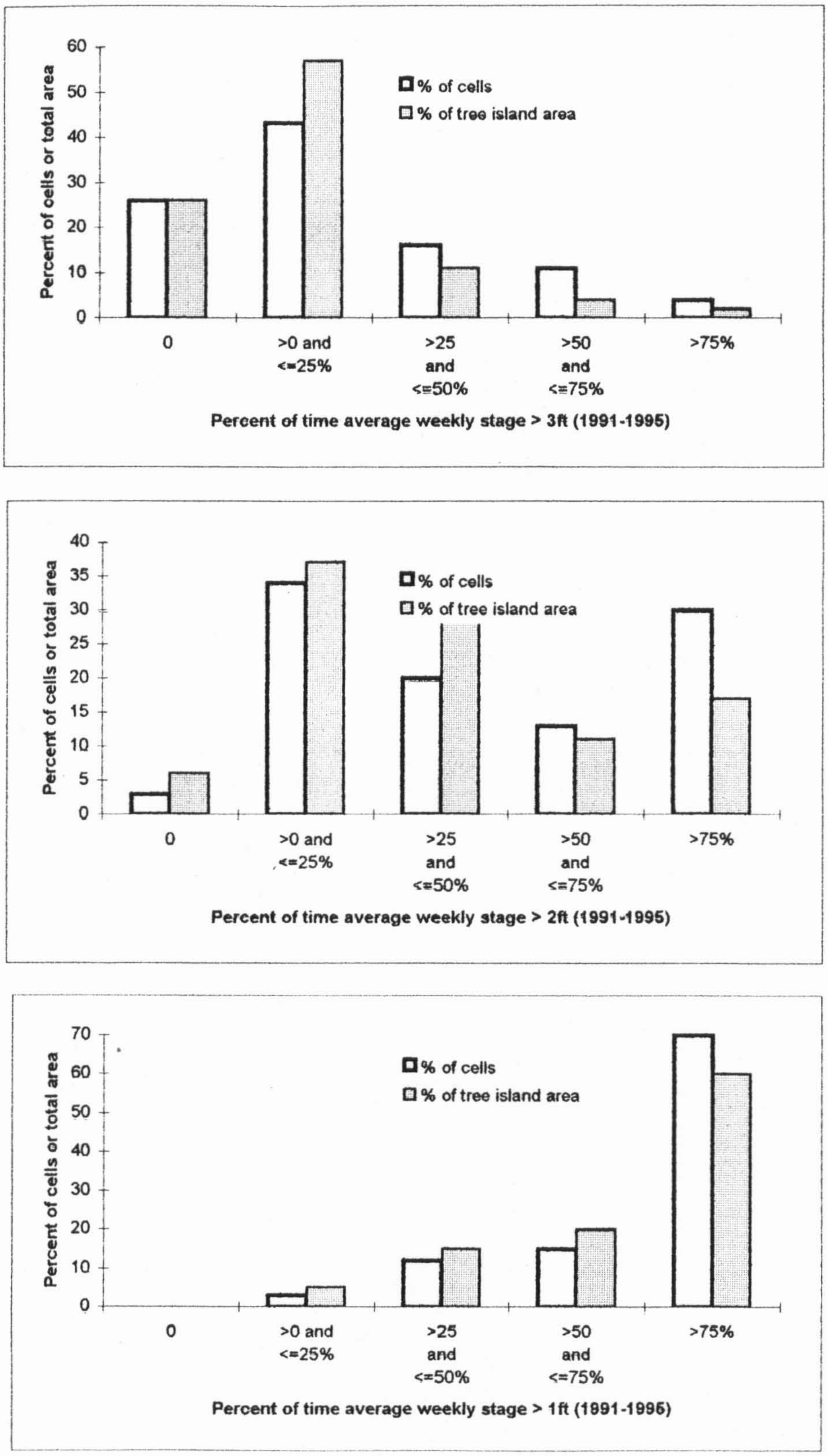
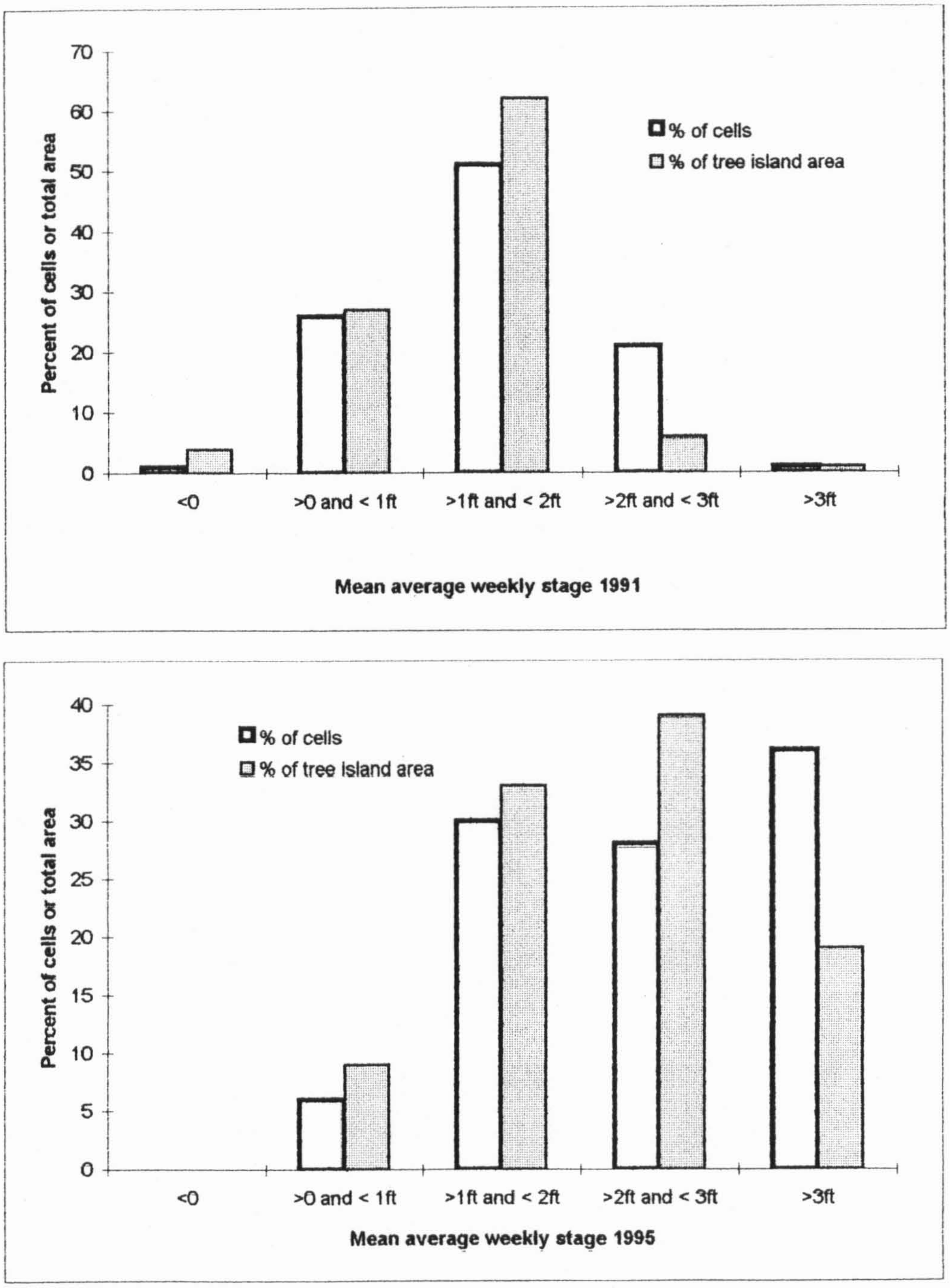


Figure 7. Percent of the time that average weekly stage was > 3, 2, or 1 ft in WCA 3 during 1991-1995. Results are expressed as either the percent of all of the cells or percent of the total tree island area that experienced each condition.



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